A novel spectral and radiometric calibration target for the TIR imager and the MARA instrument on the Hayabusa2 mission. J. Helbert[1], S. del Togno[1], A. Maturilli[1], S. Ferrari[1], M. Grott[1], B. Borgs[1] and T. Okada[2], [1]Institute for Planetary Research, DLR, Rutherfordstrasse 2, 12489 Berlin, Germany – joern.helbert@dlr.de, [2] ISAS/JAXA, Sagamihara, Japan.

Introduction: After the success of the Hayabusa mission, the first ever asteroid sample return mission [1], JAXA is preparing a follow-up mission to collect a sample from an asteroid and bring it back to Earth [2]. Hayabusa-2 will visit the C-type asteroid 1999 JU3. This class of asteroids is thought to contain more organics and water, linking them closely to the question of habitability. The target asteroid is classified as Cg-type asteroid [3] based on its 0.36-0.92 μm spectrum acquired in 1999 by the Palomar Mountain Observatory [4]. The Cg subclass is characterized by stronger UV absorption short of 0.55 μm and a relatively flat spectrum between 0.55-0.85 μm [3]. Additional spectra of 1999JU3 were acquired by the Multi Mirror Telescope (MMT) in 2007 [5], and the median of these spectra is also flat between 0.55-0.85 μm. However one spectrum shows an absorption feature at 0.7 μm, which is typical of the Ch and Cgh subclasses. This could indicate the presence of hydrous alteration (thus the h in Ch) for C-type main belt asteroids [3]. The 0.7 μm absorption feature matches a feature of antigorite, an iron rich phyllosilicate that forms by hydrous alteration [5] of olivine, and it has been proposed that the apparent variation of the spectrum in time indicates a variegated surface composition [6].

The launch of Hayabusa-2 is foreseen for end of 2014, return of the sample to Earth follows 6 years later. A mid-infrared imager (TIR) will observe the asteroid surface, with an infrared filter covering the 8 to 12 μm spectral region [7]. The Mobile Asteroid Surface Scout (MASCOT) lander will carry the MARA instrument, a radiometer with 4 spectral channels allowing basic mineralogical classification[8].

At DLR we have developed a spectral and radiometric calibration target that will allow a cross calibration of the MARA and the TIR instrument. We use a serpentinite rock sample, which in the thermal infrared shows a strong spectral slope as well as well defined spectral feature. Obtaining measurements of this target with both instruments will greatly facilitate the correlation of orbital measurements obtained by the TIR with in-situ measurements by MARA. The calibration target is portable and highly adaptable, which will allow use for future mission.

Hayabusa 2: Two important additions to the Hayabusa 2 mission are a thermal infrared imager build by JAXA on the orbiter and the lander element MASCOT (Mobile Asteroid Surface Scout) as a DLR contribution.

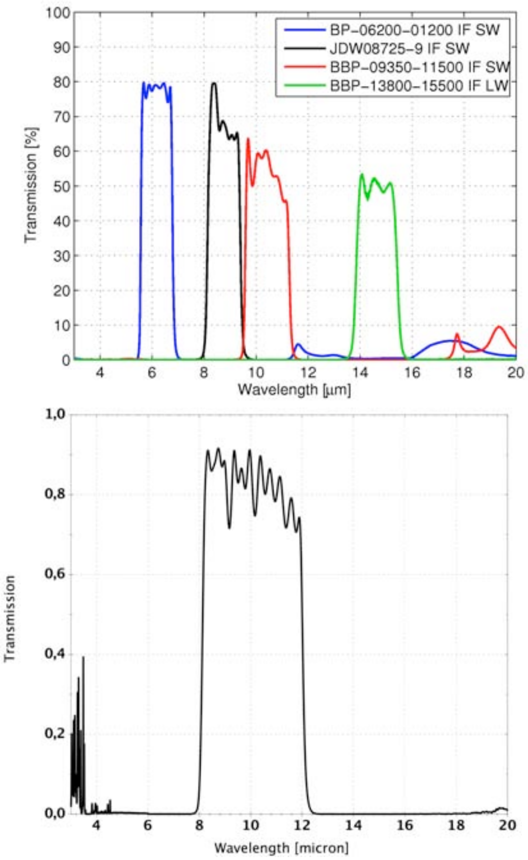

Figure 1 – top: Transmission curve for the 4 "mineralogical" filter of MARA – **bottom:** Transmission of TIR imager filter (all transmissions measured at PEL)

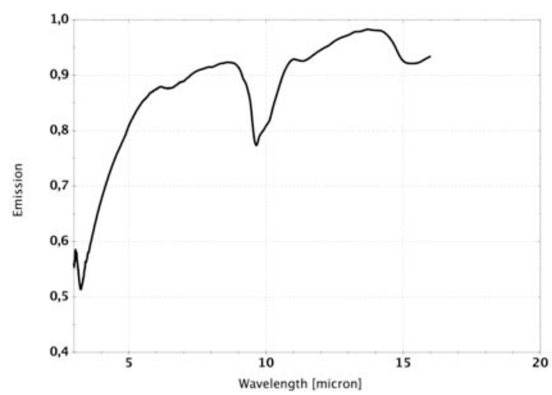

Figure 2. Emissivity of the serpentinite target measured with an MCT detector up to 16 microns at PEL.

The thermal infrared imager on Hayabusa II is building on the heritage of the LIR camera on Venus Climate Orbiter. It will image the asteroid surface with a broadband filter from 8-12µm. Its main purpose is to constrain the thermal physical properties of the surface. The MASCOT radiometer MARA is one of four instruments on MASCOT, and will determine the radiative flux from the asteroid's surface in six infrared wavelength bands. Out of these channels, four are designed as band passes at wavelengths of 5.5-7, 8-9.5, 9.5-11.5, and 13.5-15.5 µm [3], and these channels can be used for a mineralogical characterization of the investigated surface sites. Figure 1 shows the filter response of the four band pass filters of MARA on the top and the band pass filter of the TIR instrument on the bottom. All measurements have been obtained at the Planetary Emissivity Laboratory (PEL) at DLR using a Bruker A480 transmission unit with a Bruker VERTEX 80V spectrometer.

Calibrator: The calibrator is using a serpentinite rock target. Serpentine is a common rock-forming hydrous magnesium iron phyllosilicate ($(Mg, Fe)3Si_2O_5(OH)_4$) mineral. It is therefore a potential surface analog based on the classification of the target aseroid. The spectrum of the serpentinite target measured in emissivity at PEL is shown in figure 2.

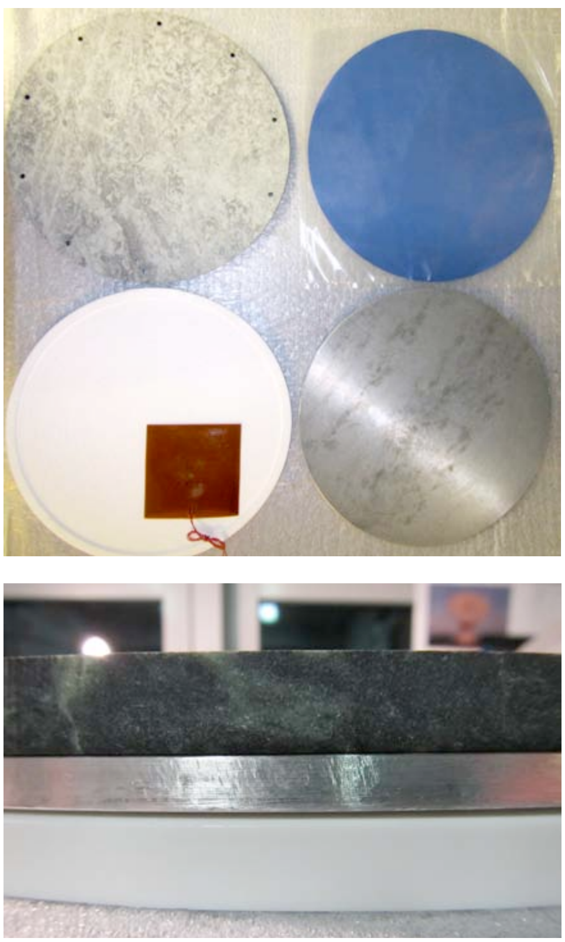

Figure 3. Top: Components of the calibration target - Serpentinite target, thermal filler, aluminium heat spreader, and teflon back with one of the four heater elements (clockwise from top left). **Bottom:** Side view of the assembled calibrator

The calibrator (Fig. 3) consist of the 1cm thick serpentinite slab with 30cm diameter. This is approximately twice the size of the field of view of both the MARA and TIR instrument. The disk is mounted with a gap filler on an aluminum heater spreader and heater with 4 Minco capton heaters. A PID controller receives temperature measurements from 3 thermopile temperature sensors mounted on the serpentine target and forms a close loop thermal control. The target can be set to temperature from 25°C to 100°C.

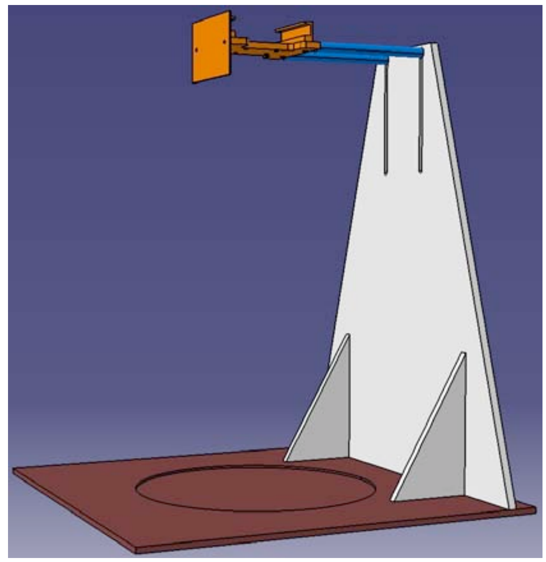

Figure 4. Mounting for the MARA calibration.

Figure 4 shows the design for the mounting of the MARA instrument for calibration at DLR. A similar setup with the same viewing geometry will be used for calibration of the TIR instrument at JAXA.

Outlook: The modular design of the calibrator allows to adapt it to a wide range of missions and instruments. The calibration target can be easily exchanged based on the characteristics of the target body. All components are vacuum capable, allowing calibration measuremnts also during thermal vacuum tests. The small size allows to transport the calibrator easily, making calibration measurements at different sites possible.

References: [1] Fujiwara, Akira, et al. (2006) *Science* 1330-1334. [2] Abe M. et al. (2012) *LPI Contribution* No. 1667. [3] Bus, S.J., Binzel, R.P., Icarus 158, 146–177 (2002). [4] Binzel, R.P., et al., Icarus 151, 139–149 (2001). [5] Vilas, F., Astron. J., 135:1101–1105 (2008). [6] Müller, T.G. , et al., Astron. Astrophys., 525, A145 (2011). [7] Okada, T.. et al. (2012) *LPS XLIII*, 1498. [8] Grott, M. et al. (2012) *LPS XLIII,* 1955.